



**International  
Standard**

**ISO 12625-16**

**Tissue paper and tissue products —  
Part 16:  
Determination of optical properties  
— Diffuse reflectance method for  
opacity (paper backing)**

**Second edition  
2024-05**

*Papier tissue et produits tissue —*

*Partie 16: Détermination des propriétés optiques — Méthode par  
réflectance diffuse de l'opacité sur fond papier*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at [www.iso.org/patents](http://www.iso.org/patents). ISO shall not be held responsible for identifying any or all such patent rights.

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 2, *Test methods and quality specifications for paper and board*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 172, *Pulp, paper and board*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 12625-16:2015), which has been technically revised.

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The main changes are as follows:

- Information has been added to [Annex A](#) to explain calculations for instruments with bandpass correction; [Table A.2](#) provides weighting functions needed for calculations related to instruments with bandpass correction.

A list of all parts in the ISO 12625 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

Optical measurements are affected by the geometry of the instruments used and by the texture of the material.

The optical properties are related to the visual appearance of the material. Although optical properties are intrinsic properties of tissue paper, they are not functional properties.

The opacity value depends on the principle used for its evaluation, and a method should be chosen which most closely relates to the interpretation to be placed upon the results. The method described in this document is applicable when it is desired to measure that property of a tissue paper or tissue product which governs the extent to which one sheet visually obscures print on underlying sheets. It should not be confused with methods based on the reduction in a standard contrast by interposition of the paper opacity (white backing), formerly known as contrast ratio, nor with the assessment of the amount and condition of light penetrating a sheet (transparency or translucency).

The calculation of opacity requires luminance-factor data obtained by measurement under specified conditions. The luminance factor depends on the conditions of measurement, and particularly on the spectral and geometric characteristics of the instrument used for its determination.

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# Tissue paper and tissue products —

## Part 16:

# Determination of optical properties — Diffuse reflectance method for opacity (paper backing)

## 1 Scope

This document specifies the testing procedures for the instrumental determination of the opacity of tissue paper or tissue products by diffuse reflectance using a paper backing.

This document contains specific instructions for the preparation of test pieces of single-ply and multi-ply products, where special preparation/procedures might be necessary.

It can be used to determine the opacity of tissue paper and tissue products containing fluorescent whitening agents, provided the UV content of the radiation incident on the test piece has been adjusted to conform to that in the CIE illuminant C using a fluorescent reference standard provided by an authorized laboratory as described in ISO 2470-1.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 186, *Paper and board — Sampling to determine average quality*

ISO 187, *Paper, board and pulps — Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples*

ISO 2469, *Paper, board and pulps — Measurement of diffuse radiance factor (diffuse reflectance factor)*

ISO 2470-1, *Paper, board and pulps — Measurement of diffuse blue reflectance factor — Part 1: Indoor daylight conditions (ISO brightness)*

ISO 4094, *Paper, board and pulps — General requirements for the competence of laboratories authorized for the issue of optical reference transfer standards of level 3*

ISO/CIE 11664-1, *Colorimetry — Part 1: CIE standard colorimetric observers*

ISO/CIE 11664-2, *Colorimetry — Part 2: CIE standard illuminants*

ASTM E308-13, *Standard Practice for Computing the Colors of Objects by Using the CIE System*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

### 3.1 reflectance factor

$R$

ratio of the radiation reflected by a surface element of a body in the direction delimited by a given cone with its apex at the surface element to that reflected by the perfect reflecting diffuser under the same conditions of illumination

Note 1 to entry: The ratio is often expressed as a percentage.

Note 2 to entry: This term may be used only when it is known that the test material exhibits no luminescence (fluorescence).

Note 3 to entry: The reflectance factor is influenced by the backing if the body is translucent.

[SOURCE: ISO 2469:2024, 3.4, modified —  $R$  added and based on ISO 5631-1:2022, 3.3, Note 3 to entry added.]

### 3.2 luminance factor (C)

luminous reflectance factor

$Y(C/2^\circ)$ -value

$R_y$   
*reflectance factor* (3.1) or radiance factor defined with reference to the CIE illuminant C and the visual efficiency function  $V(\lambda)$

Note 1 to entry: The visual efficiency function describes the sensitivity of the eye to light, so that the luminance factor (C) corresponds to the attribute of visual perception of the reflecting surface.

Note 2 to entry: For computational purposes, the function is identical with the CIE 1931 colour-matching function  $\bar{y}(\lambda)$ .

[SOURCE: ISO 2471:2008, 3.2]

### 3.3 single-sheet luminance factor (C)

$R_{y,0}$

*luminance factor (C)* (3.2) of a single sheet of paper with a black cavity as backing

[SOURCE: ISO 2471:2008, 3.3, modified — The symbol has been changed.]

### 3.4 intrinsic luminance factor (C)

$R_{y,\infty}$

*luminance factor (C)* (3.2) of a layer or pad of material thick enough to be opaque, i.e. such that increasing the thickness of the pad by doubling the number of sheets results in no change in the measured *reflectance factor* (3.1)

[SOURCE: ISO 2471:2008, 3.4, modified — The symbol has been changed.]

### 3.5 opacity

<paper backing> ratio of the *single-sheet luminance factor (C)* (3.3),  $R_{y,0}$ , to the *intrinsic luminance factor (C)* (3.4),  $R_{y,\infty}$ , of the same sample

Note 1 to entry: Opacity is expressed as a percentage.

[SOURCE: ISO 2471:2008, 3.5]

## 4 Principle

The luminance factor of a single sheet of the tissue paper or tissue product over a black cavity and the intrinsic luminance factor of the tissue paper or tissue product are determined. The opacity is calculated as the ratio of these two luminance factor values.



## 5 Apparatus

### 5.1 Reflectometer

**5.1.1 Reflectometer**, having the geometric, spectral and photometric characteristics described in ISO 2469, calibrated in accordance with ISO 2469 and equipped for the measurement of luminance factor (C).

The materials to be measured can contain fluorescent whitening agents. The reflectometer shall therefore be equipped with a radiation source adjusted to correspond to the CIE illuminant C described in ISO 11664-2. This should be achieved through the use of a fluorescent reference standard ([5.2.2](#)) as described in ISO 2470-1.

**5.1.2 Filter reflectometer**, having a filter which, in conjunction with the optical characteristics of the basic instrument, gives an overall response equivalent to the CIE tristimulus value  $Y$ , described in ISO/CIE 11664-1, of the CIE 1931 standard colorimetric system of the test piece evaluated for the CIE illuminant C.

**5.1.3 Abridged spectrophotometer** whose function permits the calculation of the CIE tristimulus value  $Y$ , described in ISO/CIE 11664-1, of the CIE 1931 standard colorimetric system of the test piece, evaluated for the CIE illuminant C using the weighting functions given in [Annex A](#).

### 5.2 Reference standards

The reference standards for calibrating the instrument and the working standards should be used with sufficient regularity to ensure satisfactory performance.

**5.2.1 Non-fluorescent reference standard**, for photometric calibration, issued by an ISO 4094 authorized laboratory in accordance with ISO 2469.

**5.2.2 Fluorescent reference standard**, for use in adjusting the UV content of the radiation incident upon the sample in order to adjust the UV setting of the instrument to conform to UV(C) conditions, as described in ISO 2470-1.

### 5.3 Working standards

**5.3.1 Two plates**, of flat opal glass, ceramic, or other suitable material, cleaned and calibrated as described in ISO 2469.

NOTE In some instruments, the function of the primary working standard can be fulfilled by a built-in internal standard.

### 5.4 Black cavity

The black cavity should have a reflectance factor which does not differ from its nominal value by more than 0,2 %, at all wavelengths. The black cavity should be stored upside down in a dust-free environment or with a protective cover.

NOTE 1 The condition of the black cavity can be checked by reference to the instrument manufacturer.

NOTE 2 The nominal value is given by the manufacturer.

## 6 Sampling

If the tests are being made to evaluate a lot, the sample shall be selected in accordance with ISO 186. If the tests are made on another type of sample, the test pieces taken shall be representative of the sample received.

When sampling finished roll products, eliminate at least the first six layers and the last six layers because of the possible presence of adhesive or mechanical damage.

On finished products, one single sheet can be made of several plies. Do not try to separate the constituting plies.

## 7 Conditioning

Mark the samples for identification and make sure that the two sides of the paper or of the product can be distinguished.

Condition the samples according to ISO 187 and keep them in the standard atmosphere throughout the test. Preconditioning with elevated temperatures should not be applied since it might change the optical properties.

## 8 Preparation of test pieces

Cut test pieces of at least 50 mm × 50 mm or 50 mm diameter, which are free from any dirt, perforation, and any obvious defects. Assemble sufficient test pieces in a pad with their top sides uppermost; the number of test pieces should be such that doubling the number does not alter the reflectance factor.

Protect the pad by placing a protecting sheet on both the top and bottom. Avoid contamination and unnecessary exposure to light or heat.

If necessary, steps shall be taken to expel the air. The pads should be carefully compressed between the protecting sheets.

Mark the pad in one corner to identify the sample and the marked side and ensure that the same side of the sheet is uppermost.

## 9 Procedure

**9.1** Because the sample can contain a fluorescent whitening agent, check that the UV setting of the instrument has been adjusted to conform to UV(C) conditions, using a fluorescent reference standard provided by a laboratory authorized to issue optical reference transfer standards of level 3 according to ISO 4094.

**9.2** Remove the protective sheets from the pad of test pieces.

Steps should be taken, without damaging the material to ensure that the pad is pressed against the measuring opening under sufficient pressure to give a compact pad, which does not intrude into the measurement sphere.

Without touching the test area, use the procedure appropriate to the instrument to measure the intrinsic luminance factor  $R_{y,\infty}$  of the top side of the test-piece pad. Read and record the value to the nearest 0,01 % of the reflectance factor.

**9.3** Remove the top test piece from the pad and, with the black cavity backing the test piece, measure the single-sheet luminance factor  $R_{y,0}$  for the same area of the test piece. Read and record the value to the nearest 0,01 % of the luminance factor.

[Subclauses 9.2](#) and [9.3](#) describe the two independent measurements which are necessary for the determination of opacity. This is not intended to imply that the two measurements shall necessarily be made in this order.